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(54) Title: COMMUNICATION SYSTEM HAVING A LIMITED NUMBER OF COMMUNICATION CHANNELS

(57) Abstract

Method of controlling communication links in a communication system, each communication link occupying at least one of a limited number of communication channels and being used for communications between communication devices (4, 5). The invention allows to establish a requested first communication link, even if a free communication channel is not available. Control means (1) are provided to determine at least one second communication link which uses at least two communication channels and to initiate a release procedure for at least one of the communication channels of the identified communication link. The released communication channel is used to establish the requested first communication link. After termination of the requested and established link, the communication channel may be returned to restore the at least one second communication link. The invention can equally be applied to ISDN–systems as well as to mobile communication networks.

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Communication system having a limited
number of communication channels

5   [Field of Invention]

The present invention relates to a system and a method of
controlling a communication system, and in particular, the
present invention relates to controlling communication
10   links in a communication system having a limited number of
communication channels, wherein each communication link
occupies at least one communication channel.

[Background of the Invention]
15

In today's computerized world, telecommunication networks
are increasingly used to transmit data between computers.
Telecommunication networks, however, have been designed
mainly for the transmission of speech signals and
20   therefore are not well equipped for the transmission of
digital data at high data rates. Furthermore, subscribers
of telephone networks increasingly demand simultaneous use
of both, a computer in a data transmission session and a
telephone in a telephone call.
25

One solution to this problem is to link the subscriber,
e.g. his household or his workplace with multiple
telephone lines which can be used for data or speech
transmission at his discretion.
30

Integrated Services Digital Network ISDN has been
developed to provide a subscriber with multiple lines for
independent use. If a user has subscribed to ISDN
services, he will have two digital telephone lines with
35   each 56-64 kbit/s for the transmission of
speech signals or the transmission of data. The ISDN
subscriber could now connect his computer to one of the

two so-called B-channels of the ISDN system. Via this
first B-channel the ISDN subscriber could, e.g. connect to
an Internet access point while he would still have the
second B-channel available for making phone calls or being

5   called by an outside subscriber. Further, ISDN provides a
so-called D-channel. The D-channel is a general packet
data channel. In general, the D-channel may be used for
both signaling between a user terminal and the ISDN Local
Exchange and user voice/data transmission.

10
With the demand for ever higher rates of data
transmission, in many cases the ISDN subscriber will want
to use both B-channels of the ISDN service for a data
transmission session between his computer and, for

15   example, an Internet Access Server. Data communication
protocols are available, e.g., multi-link PPP, which
provide the option to connect and exchange data via
multiple individual lines or communication channels.

20   Consequently, if the ISDN subscriber uses both B-channels
of the ISDN service for a data transmission session, there
is no line available for receiving an outside call or for
making a call towards the outside. A user calling from the
outside would receive a busy signal, since no B-channels

25   are available, and the ISDN subscriber connected with his
computer will also not have a free channel for making a
call to the outside.

Therefore, a problem arises when the ISDN subscriber has
30   connected himself to, e.g., an IAS (Internet Access
Server) via both of his only two B-channels of his ISDN
service. If the subscriber now suddenly gets a phone call
via a telecommunications network, the calling subscriber
will experience a busy signal. And most likely the ISDN
35   subscriber wants to avoid this situation. He would like to

use both lines for the data transmission session, but he
also would like to be reachable by telephone.

In ISDN applications it is basically possible to use the
5   D-channel for a transmission of user data, thus for a
telephone call or a data transmission session. The basic
problem, however, remains the same, at one point all
available channels may be occupied.

10   To solve this problem, a so-called feature "Call Waiting"
has been proposed in the "European Telecommunication
Standard ETS 300058-1", October 1991 from the European
Telecommunication Standards Institute. This service "Call
Waiting" allows to send a SETUP request as part of the
15   ISDN protocol via the D-channel, although both B-channels
of the ISDN system are occupied. This SETUP request allows
a terminal to pick up the call, however, only a terminal
using a B-channel at this point in time are allowed to do
so. This means that in the above case with a computer
20   connected in a data transmission session via both B-
channels, only the computer is allowed to pick up the
call.

This is not only inconvenient, since only the computer may
25   be used for a telephone call, it also implies that the
computer must be equipped with a microphone and speaker
and be compatible with the speech bearer service.

It is obviously desired, that the call may be picked up by
30   any telephone terminal, e.g., by a telephone set next to
the computer or in a different room. This, however, is not
possible with the above ISDN "Call Waiting" service, since
a B-channel is not available for the telephone terminals
(both B-channels are occupied by the data transmission
35   session).

Further, it is disadvantageous, that the "Call Waiting" feature does not help when the ISDN subscriber involved in a data transmission session occupying two B-channels (a 2B-channel session) wants to make an outgoing telephone
5   call. In order to make a telephone call, the user has to disconnect at least one of his ISDN B-channels involved in the data transmission session.

Moreover, the "Call Waiting" feature might also disturb
10 the data transmission session, e.g., the multi-link PPP-session, if one of the PPP-connections is suddenly put on HOLD.

[Summary of the Invention]
15

In view of the above problems it is object of the invention to provide a system and method for flexibly assigning communication channels to communication links.

20 This object of the invention is solved by a method for controlling communication links in a communication system with the features of claim 1.

The object of the invention is further solved by a
25 communication system with the features according to claim 11.

The invention allows to establish a communication link, even in cases, where a free communication channel is not
30 available, by detecting at least one second communication link occupying at least two communication channels, releasing at least one of the communication channels of the at least one second communication link and establishing the requested first communication link using
35 the at least one released communication channel.

Subsequently, in case a communication channel becomes
available thereafter, the second communication link may be
restored to its original state by resuming communication
via this or these communication channels.

5

Advantageously, in case the first communication link is
terminated, its at least one communication channel may be
released and the at least one second communication link
may resume communication via the released channels of the

10   first communication link.

Also, in case the first communication link is terminated,
the devices communicating via the at least one second
communication link may be notified by control means and

15   instructed to resume use of the at least one released
communication channel of the first communication link.

Further, it is possible that at least one of the devices
communicating via the at least one second communication

20   link performs regular check-ups of the state of the
communication channels and resumes use of a released
channel, in order to restore the corresponding
communication link to its original state, that is, to the
state before at least one of its communication channels

25   has been released.

Advantageously, in order to avoid an erroneous release of
communication channels of a communication link using at
least two communication channels, a service record may be

30   checked and it may be determined whether the target
communication link is marked available for releasing at
least one of its communication channels.

The invention may advantageously be also applied to

35   systems employing ISDN (Integrated Services Digital
Network), e.g., in case data processing units are involved

in a data transmission session and conduct a multi-link
PPP-session via the two ISDN-B-channels, and an outgoing
or an incoming telephone call occurs.

5   The invention may also be applied to mobile communication
      networks, in which case the communication devices include
      mobile communication units of the mobile communication
      network.

10   Further advantageous embodiments of the invention are
      disclosed in further dependent claims.

      The invention may be better understood when read in
      conjunction with the accompanying drawings:

15

      [Brief Description of the Figures]

      Fig. 1   illustrates in a time/flow diagram an embodiment
                  of the method according to the invention;

20
      Fig. 2   shows a time/flow diagram of part of an
                  embodiment of the method according to the
                  invention;

25   Fig. 3   shows time/flow diagram of another embodiment of
                  the invention, applied to an ISDN (Integrated
                  Services Digital Network) system;

      Fig. 4   shows a time/flow diagram of another embodiment
30   of the invention, applied to a mobile
                  communication network;

      Fig. 5   shows in a block diagram an embodiment of the
                  system according to the invention, applied to an
35   ISDN network; and

Fig. 6   shows a block diagram of yet another embodiment
of the system according to the invention,
applied to a mobile communication network.

5   [Detailed Description of Embodiments]

In the following, preferred embodiments of the invention
are described with respect to the figures.

10   Fig. 1 shows a time/flow diagram illustrating an example
of the method according to the invention. Part of a
communication system including control means 1 (CM), two
data processing units 2, 3 (DPU) and two telephone
terminals 4 and 5 (TT) are illustrated. Even if not shown,
15   the communication system may include further communication
devices.

The control means 1 controls communications between the
communication devices. It establishes communication links
20   between two devices or groups of devices. A communication
link is the medium employed by communication devices for
communications. A communication link therefore carries
information concerning a single communication process,
e.g., speech signals between at least two telephone
25   terminals or data exchanged between at least two data
processing units. A communication link supports
communications between at least two communication devices.

Communication links occupy at least one communication
30   channel, e.g., a communication link between two telephone
terminals may occupy one channel, a communication link
between data processing units may occupy two communication
channels or an even larger number of channels. A
communication link can usually be established using a
35   single communication channel, even though higher data

rates can be achieved by using a plurality of communication channels for a communication link.

A communication channel can be a physical line, for
5   example a telephone line, or it can be a virtual line, e.g. a fixed time slot on a multiplexed connection.

The control means 1 is responsible for controlling communications between communication devices. In
10 particular, the control means is responsible for controlling the use of communication channels by communication links.

In the example of Fig. 1, it is assumed that the two data
15 processing units 2, 3 communicate using a communication link which occupies at least two communication channels. Further, it is assumed that a user of telephone terminal 5 makes a phone call to reach a user at telephone terminal 4, i.e., dials the telephone number of telephone terminal
20 4. Thus, a communication link between the telephone terminals is requested by telephone terminal 5.

In case, a free communication channel of the communication system is available, the requested communication link can
25 readily be established in a conventional manner. However, in case all communication channels are occupied, the requested communication link cannot directly be setup.

In the following it is outlined with respect to Fig. 1,
30 how, according to the present invention the requested communication link may still be established in the above case.

Generally speaking, this can be achieved by "borrowing" a
35 communication channel from another communication link. In the present case it is assumed that a communication

channel from the communication link between the two data
processing units 2 and 3 will be borrowed.

It is further outlined with respect to Fig. 1, after the
5   requested communication link or any other communication
link has been terminated, how the communication link
between the data processing units 2 and 3 can be restored
to its original state, i.e., to the state before a
communication channel was borrowed.
10

On the right side of Fig. 1, steps S11 - S14 are
indicated, involved in the procedure to establish the
requested communication link between the two telephone
terminals 4 and 5. This is the call setup procedure.
15

Further, steps S15 - S17 of a call release and resume
procedure are indicated, concerning the release of the
communication channel after the termination of the
requested communication link, and resuming the use of the
20   released communication channel for the communication link
between the data processing units 2 and 3.

On the left side of Fig. 1, the arrow 20 denoted with the
parameter t indicates time during the call set-up
25   procedure and the call release and resume procedures.

First, the call set-up procedure is outlined in detail.

In step S11 a request for a communication link between
30   telephone terminals 4 and 5 is issued by the telephone
terminal 5, as indicated with an arrow 100. This request
for a communication link, the setup request, is detected
by the control means 1.

35   Following, in step S12, the control means 1 determines,
whether a free communication channel is available to set

up the requested communication link. It is understood that
in case a communication channel were available, a
communication link between the telephone terminals 4 and 5
may be established in a known manner. In the example of

5   the present embodiment, however, it is assumed that a free
communication channel is not available. Therefore, as
indicated by a reference sign 101, the control means 1
performs a detection procedure to identify a communication
link occupying at least two communication channels. In the

10   present example, it assumed that the control means detects
the communication link between the two data processing
units 2 and 3 which, as mentioned above, occupy at least
two communication channels.

15   In the following, in a step S13, a release or
disconnection of one of the communication channels of the
identified or target communication link, i.e., the
communication link between the two data processing units 2
and 3, is initiated. A disconnect command, as indicated at

20   a reference sign 102, is sent from the control means 1 to
one or both data processing units 2 and 3, which in
response thereto release one of the communication channels
of the communication link used for the data transmission
session. Note that the data transmission session is still

25   conducted using the remaining communication channel or
channels.

Following, in a step S14, the control means 1 initiates
establishing the requested communication link between

30   telephone terminals 4 and 5. This involves sending a setup
message, as indicated using a reference sign 103, from the
control means 1 to the telephone terminal 4. The
communication link may now be established in a known
manner.

35

It is noted, that the data transmission session via the
communication link between the two data processing units 2
and 3 is still in progress, however, at a reduced data
transmission rate, while the requested telephone

5   communication link has now been established between the
two telephone terminals 4 and 5.

In the example of Fig. 1 it is assumed that a
communication link between two telephone terminals

10   requiring a single communication channel is requested and
established. However, in other examples, more than one
communication channel could be requested, for example by
further communication devices, e.g. for a data
communication or video transmission.

15
In this case, in step S12, the control means could try to
identify a single communication link using a sufficiently
large number of communication channels and request the
release of a plurality of communication channels in the

20   disconnect command of step S13.

Further, in this case, the control means 1 could try to
identify a plurality of communication links using at least
two communication channels and request the release of at

25   least one communication channel each. Thus, in step S13
several disconnect procedures, could be included and,
accordingly, step S14 would include several setup
procedures for establishing the requested communication
link.

30
Further channel request scenarios are possible, e.g., a
plurality of requests for establishing communication
links, resulting in a plurality channel release
procedures.

35

Step S12, in further examples, may also include a look-up procedure in a service record storing information about individual communication links in order to verify that the identified communication link or links using at least two

5   communication channels are marked available for releasing communication channels. Also, a determination step could be included to determine how many communication channels of the targeted communication link or links are available for release.

10

Also, the selection of a target communication link for a release of communication channels may follow priority considerations, i.e., the determination step could include determining a priority of a communication channel,

15 according to which the control means 1 decides to initiate a release of a channel or not.

In the following the call release and resume procedure of the steps S15 - S17 is described in detail.

20

At a certain time instant the telephone conversation via the communication link between telephone terminals 4 and 5 is terminated, e.g., by hanging up the handle of telephone terminal 4. Accordingly, in a step S16 a release message,

25 as indicated with a reference sign 104, is issued by telephone terminal 4 and received by the control means 1. Of course, in further cases, the released message could have been issued by telephone terminal 5 as well.

30 In a step S16, in response to the release message of step S15, the control means 1 may send a termination message, as indicated with a reference sign 105, to telephone terminal 5.

35 Following, in a step S17, the control means 1 may send a notification message, as indicated with a reference sign

106, to the data processing units 2 and 3, or one of them, that the borrowed communication channel is available again.

5   Subsequently, the communication link between the data processing units 2 and 3 can be restored to its original state, i.e., the state before a communication channel was borrowed, by resuming use of the released communication channel of the terminated telephone conversation. Of

10   course, a communication link may also be only partially restored to its original state, according to availability of released communication channels.

It is noted that, in case the communication system
15   includes more communication devices than shown in Fig. 1, not necessarily the specific communication channel of the requested and established telephone link must be used, any other released communication channel could be used instead, to restore the communication link between the
20   data processing units 2 and 3 to its original state.

It is also possible that the data processing units 2 and 3 are not notified by control means 1 in step S16, but poll the status of the communication channels from time to time
25   in order to detect a released communication channel using poll means 504 (P). This may be a specific communication channel or an arbitrary one, as outlined above. In case a released communication channel is detected, the data processing units could restore their communication link to
30   its original state by using the detected free communication channel.

In case the requested communication link between telephone terminals 4 and 5 occupied more than one communication
35   channel and/or the communication link between the data processing units 2 and 3 occupied more than two

communication channels, the call release and resume procedure of the steps S15 – S17 may involve a plurality of channel release and resume steps, until the communication links between data processing units 2 and 3

5   and possibly between further communication devices are restored to their original state.

The invention is not limited to communication links established or requested between two parties, e.g.,

10   besides the data processing units 2 and 3 a larger number of communication devices could be engaged in a group call and further telephone terminals may be involved in the requested communication link, which, in the example of Fig. 1, is to be established between telephone terminals 4

15   and 5.

In the embodiment of Fig. 1 telephone terminals 4 and 5 and data communication devices 2 and 3 are used, however, only by way of an example for illustrating the invention.

20   In further embodiments, instead of the data processing units 2, 3 and the telephone terminals 4, 5, any communication devices could equally well be used. For example, data processing devices may request a communication link instead of the telephone terminals 4

25   and 5.

Fig. 2 illustrates an example of part of the method according to the invention, as outlined with respect to Fig. 1.

30   Fig. 2 illustrates an example of a procedure for releasing a communication channel of a communication link occupying more than one communication channel, e.g., as outlined with respect to step S13 in Fig. 1.

35

Fig. 2 shows part of a communication network including two
data processing units 2 and 3 and control means 1. The
data processing units may, e.g., be involved in a data
transmission session using a multi-link PPP-protocol. The
5   arrow, as indicated with a reference sign 20, indicates
time during the disconnect procedure. In the example of
Fig. 2 it is assumed that the control means 1 has already
received a request for a communication link and has
identified the communication link between data processing
10   units 2 and 3 as occupying a plurality of communication
links.

The control means 1 issues a disconnect command, as
indicated with a reference sign 200, to one or both of the
15   data processing units 2 and 3, requesting the
disconnection of a specified number of communication
channels. In response to the disconnect command form the
control means 1, the data processing units 2 and 3
initiate the release of the requested number of
20   communication channels. This may involve steps for
terminating a transmission of data via these communication
channels, in order to avoid any data loss due to an
unexpectedly interrupted communication channel.

25   Thereafter, the communication devices 2 and 3 will reply
with a release message, as indicated with a reference sign
201, indicating that the release of the requested
communication channels may now be performed. Subsequently,
the control means will terminate communications via the
30   specified communication channels and may issue a release
complete message, as indicated with a reference sign 202,
which is sent to the communication devices 2 and 3.

Thereafter, the released communication channels are
35   available for establishing the requested communication

link in a call SETUP, as indicated with a reference sign
203.

Fig. 3 shows an embodiment of the method according to the
5   present invention applied to an ISDN-system. ISDN
(Integrated Digital Services Network) is a digital system
for a simultaneous transmission of a voice and data. The
features of ISDN were further outlined in the introductory
section. ISDN provides two B-channels or bearer channels
10   at, e.g., 64 kbit/s each. Further, ISDN provides a D-
channel or data channel, for data or signaling control
information. Thus, ISDN can be considered providing 2 B +
D channels. The two B-channels can be used by a subscriber
for transmitting speech signals or data. In the present
15   example it is assumed that the D-channel is not available
to the subscriber for speech or data transmission.

ISDN is increasingly used in private environments, by
subscribers wishing to be connected by two communication
20   channels (the two B-channels). The subscriber can
individually use the two communication channels at his own
discretion, he may use each for data or speech
transmission. However, as outlined in the introductory
section, for achieving high data rates, the subscriber may
25   also connect both communication channels in a data
transmission session, for example, with an Internet
provider. In this case the subscriber can not readily make
a phone-call nor can he be readily reached by a telephone-
call from the outside, as stated above.
30
In Fig. 3, as in previous examples, control means 1, a
data processing unit 2, and two telephone terminals 4 and
5 are illustrated. Further, a data processing unit 6 is
shown. This data processing unit may be, e.g, an Access
35   Server IAS, for connecting to a computer network.

As indicated by reference signs 301 and 302, the two data processing units 2, 6 are involved in a 2 B-channel data transmission session. The data processing units are thus occupying both communication channels available to the

5   ISDN subscriber. In the above example the first data processing unit 2 may, e.g., be a data processing unit operated by the ISDN-subscriber, the second data processing unit 6 may for example be another computer or an Internet access server for accessing the world-wide

10   web. The two data processing units 2 and 6 may, for example, conduct a communication using a multi-link PPP-protocol. However, this is an example only, the data processing units may use any other protocol, the important fact is that they occupy both B-channels for exchanging

15   information via the communication link established between each other.

Further, it is assumed that the ISDN subscriber has access to telephone terminal 4. Thus the ISDN subscriber operates

20   both, the telephone terminal 4 and data processing unit 2.

It is now assumed, that someone from the outside, via a telephone terminal 5, tries to reach the ISDN-subscriber at his telephone terminal 4. Therefore, in a step S32, the

25   telephone terminal 5 will issue a communication link request, as indicated with a reference sign 303, which is received by control means 1. The control means 1 in the present example may be the local exchange of the ISDN-network. This request for a communication link therefore

30   may be an Initial Address Message IAM or a SETUP message. The request message may be transmitted via a public telephone network or any other communication network.

After receiving the request for a communication link, in a

35   step S33, and indicated with a reference sign 304, the control means 1 checks, whether the 2 B-channels towards

the ISDN-subscriber are both occupied. This will be true,
since the data processing unit 2 of the ISDN-subscriber is
involved in a data transmission session within data
processing unit 6 using the 2 B-channels, as it was

5   outlined above with respect to reference signs 301 and
302.

Step S33 may also involve checking a service record for
determining whether one of the B-channels is available for

10   release. It is noted, that both B-channels have to be
occupied by the same communication link. In case they are
not occupied by the same communication link, the calling
subscriber may receive a busy signal or a "Call Waiting"
feature may be involved.

15

Since both B-channels are involved in the data
transmission session between the data processing units 2
and 6, in a step S34, a disconnect command, as indicated
with a reference sign 305, will be issued by the control

20   means 1 and forwarded to the data processing units 2 and
6. In response to the disconnect command issued to the two
data processing units 2, 6, one of the two B-channels is
released and made available for establishing the requested
communication link between the two telephone terminals 4

25   and 5.

Subsequently, in a step S35, a connection setup message,
as indicated with a reference sign 306, is issued by the
control means 1 towards the telephone terminal 4 of the

30   ISDN-subscriber and the requested communication link is
established.

It is noted that the invention also allows that a call is
being made from the telephone terminal 4 of the ISDN-

35   subscriber, in which case in step S32 the request for a
communication link is not issued by telephone terminal 5

but issued by the telephone terminal 4 of the ISDN-
subscriber and the request could be transmitted via the D-
channel to the control means, e.g., the local exchange.
The setup message of step S35 would be issued towards the
5   called telephone terminal, in this case telephone terminal
5.

After these steps the data transmission session between
data processing units 2 and 6 is still in progress,
10 however, at a reduced data rate, while the requested
telephone conversation has been established.

If now either one of the parties engaged in the telephone
conversation hangs up his hand-set, a release message, as
15 indicated with a reference sign 307, will be transmitted
to the control means 1. In the present example, it is
assumed that the hand-set of telephone terminal 4 is hung
up. Therefore, in a step S36, a release message is issued
by telephone terminal 4. The release message may also be
20 forwarded to the telephone terminal 5. Subsequently, the
communication channel between the two telephone terminals
will be released and thus again be available for use by
the data transmission session between the data processing
units 2 and 6.
25
Therefore, in a step S37 the control means will issue a
setup message, as indicated with a reference sign 308,
towards one or both of the data processing units 2 and 6
which in the following, will restore the data transmission
30 session via the two B-channels.

In other embodiments, alternatively to step S37, one or
both data processing units 2, 6 may, in regular intervals,
may check the status of the B-channels, and, in case the
35 second B-channel becomes available after termination of
the telephone conversation between the telephone terminals

4 and 5, may regain use of the second B-channel. In this case a setup message from the control means 1 is not required.

5   In case the communication link for the telephone conversation is requested by the telephone terminal 4 of the ISDN-subscriber, the request for a communication link may be transmitted via the D-channel of the ISDN-system towards the local exchange. The local exchange may then
10 check whether both B-channels are being used in the same communication link, and, in case this is true, the released procedure of one of the B-channels may be initiated.

15 As stated above, the invention may also be applied to communication networks, and in particular, to mobile communication networks, e.g. to networks according to the GSM-standard.

20 Fig. 4 shows another embodiment of the invention, applied to a telecommunications network.

    In mobile communication networks, a communication channel may be a time slot on a multiplexed transmission medium,
25 e.g. a frequency band. A base station is responsible for establishing communication links with a plurality of mobile units, by way of assigning a particular time slot on the transmission medium to one particular mobile station. Usually, a particular time slot on the
30 transmission medium is associated with a particular communication channel.

    A communication link between a mobile station and the base station may use at least one communication channel, i.e.,
35 at least one particular time slot. A particular communication channel in a mobile communications network

has a specific bandwidth. If now a communication link with a larger capacity is required, for example, a larger number of communication channels (time slots) may be assigned to a particular communication link between the
5   base station and the corresponding mobile station, e.g., up to eight channels.

Fig. 4 illustrates four mobile communication units (MT) 8, 9, 10 and 11. The mobile communication units may be mobile
10   telephones or data processing units, cameras, etc., linked to a mobile terminal. Again, control means 1 are provided for controlling the assignment of communication channels to communication links. Further communication devices of the mobile communication network are not shown.
15
It is assumed, that the second and third mobile communication units 9 and 10 are involved in communications, as indicated by reference signs 400 and 401. In the example of Fig. 4, it is assumed that the
20   mobile communication unit 9 and the mobile communication unit 10 are involved in a data and/or voice communication using multiple communication channels.

It is further assumed that the fourth mobile communication
25   unit 11, in a step S42, issues a request for a communication link with the first mobile communication unit 8, as indicated by a reference sign 402. And, as above, it is assumed that free communication channels for establishing the requested communication link are not
30   available.

Therefore, in a step S43 the control means 1, after receiving the request for the communication link from unit mobile communication unit 11, checks all other
35   communication links, in order to determine a communication link using multiple channels, as indicated by a reference

sign 403. In the present embodiment, for explanatory
purposes, it is assumed that the communication link
between the second and the third mobile communication unit
9 and 10 is identified as using a plurality of
5   communication channels.

It is noted that in other examples a plurality of
communication links occupying at least two communication
channels may be identified, for example, if the requested
10   communication link requires a plurality of communication
channels. Also, as in previous examples, a service record
may be checked beforehand, in order to determine, whether
the indentified communication links are marked available
for releasing at least one of their communication
15   channels.

Subsequently, in a step S44 the control means 1 issues a
disconnect command, as indicated by a reference sign 404,
for disconnecting at least one communication channel,
20   towards the second mobile communication unit 9 and/or
third mobile communication unit 10.

This disconnect message issued by the control means 1 may,
in other examples, also be sent to further communication
25   devices involved in communication links targeted for the
release of communication channels. Further, a request for
release of communication channels according to
characteristics of the involved communication links may be
considered. For example, the request may depend on the
30   number of communication channels requested by the fourth
mobile communication unit 11, on the number of
communication channels occupied by the targeted
communication links and may depend on priority
considerations.

35

Thus, the control means 1 may flexibly determine a
multiple number of communication links using at least two
communication channels, and issue disconnect commands to a
plurality of mobile communication units.

5

In the present example, in a step S45, the control means 1
issues a setup message, as indicated by a reference sign
405, to the first mobile communication unit 8, allowing
the first and the fourth mobile communication unit 8 and
10   11 to use the released communication channels for the
requested communication link. The requested communication
link can now be established in a known manner.

The release and resume procedures, if one communication
15   link is terminated, may in general correspond to the
released and resume procedures outlined with respect to
the steps S15 - S17 of Fig. 1.

A communication channel, which becomes available due to a
20   termination of a communication link, may be assigned to
any communication link, preferably however, to
communication links which were instructed to release at
least one of their communication channels. Thus,
communication channels may dynamically be assigned to
25   communication links according to availability, demand and
priority considerations.

In the following, with respect to Fig. 5, an embodiment of
the communication system according to the invention is
30   described.

The example of Fig. 5 includes an ISDN system, as
previously outlined with respect to Fig. 3. On the left
side of Fig. 5, an telephone terminal 4, preferably an
35   ISDN telephone terminal, and a data processing unit 2 are
illustrated, operated by an ISDN-subscriber.

A first switching means 500 constitutes an interface between lines from the telephone terminal 4, the data processing unit 2 and the ISDN channels. Again, control

5   means 1 are provided for controlling the assignment of communication channels to communication links. In the present example, the control means 1 consists of a first detection means 501 for receiving a request for a communication link and for receiving a termination message

10 in case a communication link is terminated. The control means 1 further comprises second detection means 502 for determining a communication link which occupies both B-channels of the ISDN-system. The control means 1 comprises second switching means 503 for physically assigning

15 communication channels to communication links.

Further, as shown in Fig. 5, the system comprises a second telephone terminal 5 and a second data processing unit 3. The second telephone terminal 5 may be connected to the

20 communications system via a public land mobile network PLMN, a public switched telephone network PSTN or any other telephone network. The second data processing unit 3 may, e.g., be another computer or may constitute a gateway to a network of data processing units, as for example the

25 Internet. Thus, the data processing unit 3 may be an Internet access server or similar. Two ISDN-B-channels are provided between the first switching means 500 and the second switching means 503. Further, a ISDN-D-channel is provided between the switching means in order to transmit

30 control information.

In the following, the operation of the shown embodiment is described by way of an example. Only cases are considered, where the D-channel is not available for user data

35 transmission. However, the invention may also be readily

applied to cases, where the D-channel is available for
user data transmission.

It is assumed, that the data processing units 2 and 3 are
5   engaged in a data transmission session and occupy both
ISDN-B-channels, e.g., using a multi-link PPP-protocol. It
is further assumed that the first telephone terminal 4 is
called using the second telephone terminal 5. Thus the
second telephone terminal 5 may issue a request for a
10   communication link. The first detection means 501 receive
the request for a communication link from the second
telephone terminal 5. Obviously, a free communication
channel, i.e., a free B-channel, is not available.

15   Accordingly, the second detection means 502 determines,
whether both B-channels are occupied by the same
communication link and possilby whether one of the B-
channels is available for a release.

20   Since in this example it is assumed that both B-channels
are occupied by a data transmission session between the
first and second data processing units 2 and 3, the
determination step will identify as target the
communication link between the two data processing units.
25
In the following, the first and second switching means 500
and 503 will be instructed to release of one of the B-
channels, and will switch the communication channel in
order to establish the communication link between the two
30   telephone terminals 4 and 5.

As a consequence, the data transmission session between
the data processing units is still in progress, however,
at reduced data transmission rate, since one of the
35   occupied B-channels was released. Further, the telephone

conversation between telephone terminals 4 and 5 has been established.

If now one of the telephone terminals is hung up, the
5   first detection means 501 will receive a termination message notifying about the termination of the communication link between the first and the second telephone terminals 4 and 5. Following the switching means will initiate resuming the communication link between the
10 two data processing units using the released B-channel, and as a result, the original state of the communication link between the data processing units is restored.

In the above example it was assumed, that the telephone
15 conversation was initiated by telephone terminal 5. However, it is also possible, that the telephone terminal 4 is used in an attempt to establish a communication link between the two telephone terminals. In this case a request for a communication link will be transmitted from
20 the first telephone terminal 4 to the second switching means 503 via the D-channel for transmitting control information.

It is also possible, that poll means 504 are provided in
25 order check in regular time intervals the status of the ISDN-B-channels in order to detect the release of the B-channel used by the telephone conversation.

It is noted, that this embodiment is not limited to ISDN,
30 in other embodiments the invention may equally well be applied to different but similar systems. Also, a larger number of communications channels may be available and a larger number of communication devices may be provided, as outlined with respect to previous examples.

35

Fig. 6 describes another embodiment of the present
invention, involving a mobile communication network,
similar to the example outlined with respect to Fig. 4.
Here a base station (BTS) 7 is responsible for

5   establishing and maintaining communication links between a
large number of mobile communication units, of which
mobile communication units 12, 13, 14 and 15 are shown.
For explanatory reasons, in the present example it is
assumed, that the first and second mobile communication

10   units 12 and 13 are constituted by mobile telephones, and
the third and fourth mobile communication units 14 and 15
are constituted by data processing units equipped with a
mobile terminal. The base station 7 is connected to a
public land mobile network PLMN, a public switched

15   telephone network PSTN, an Internet or any other network.
Control means 1 for controlling the communication links
are connected to the base station 7.

As outlined with respect to Fig. 3, again, the

20   communication links between the base station 7 and the
mobile communication units 12, 13, 14 and 15 may occupy an
arbitrary number of communication channels.

In the following, the operation of the system is

25   described, in case a sufficient number of communication
channels is not available for establishing a requested
communication link.

Initially, a request for a communication link is received,

30   either from one of the mobile communication units 12, 13,
14 and 15, from a telephone network or from a network of
data processing units. Following, the control means 1 will
determine whether sufficient communication channels are
available for establishing the requested communication

35   link.

For the purpose of explanation is assumed, that a
sufficient number of communication channels is not
available. Therefore, the control means 1 will determine
at least one communication link between the base station

5   and the mobile communication units, which occupies at
least two communication channels and are available for
releasing communication channels. Following, the release
of a specified number of communication channels of the
targeted communication links will be initiated. Again, as

10   outlined with respect to Fig. 3, the number of to be
released communication channels may be determined
according to certain parameters, as for example priority,
number of occupied communication channels, etc.

15   When an appropriate number of communication channels has
been released from existing communication links, the
control means 1 will initiate the establishing of the
requested communication link between one of the mobile
communication units and the calling party.

20

As outlined with respect to further embodiments, if one of
the communication links is terminated, i.e., if
communication channels become available, they may be used
for restoring communication links which had been

25   instructed to released a certain number of their
communication channels.

Claims

5   1. Method of controlling communication links in a
communication system, each communication link occupying at
least one communication channel and being used for
communications between at least two communication devices
(2 - 6, 8 - 15), comprising:

10

detecting a request for a first communication link (100;
303; 402);

establishing the requested communication link, if free
15   communication channels are available; and

if free communication channels are not available;

detecting at least one second communication link
20   occupying at least two communication channels;

releasing at least one of the communication channels
of the at least one second communication link; and

25   establishing the first communication link using the
at least one released communication channel.

2. Method of controlling communication links of a
communication system according to claim 1, characterized
30   in that, in case communication channels become available,
these communication channels are used by the at least one
second communication link until its original state is
reestablished.

35   3. Method of controlling communication links of a
communication system according to claim 1, characterized

in that, in case the first communication link is terminated, the at least one communication channel of the first communication link is released and the at least one second communication link is resumed using the at least
5   one released communication channel.

4. Method of controlling communication links of a communication system according to claims 1 or 3, characterized in that the communication devices
10   communicating via the at least one second communication link are notified using control means (1) in case the first communication link is terminated and instructed to resume the use of the at least one communication channels of the first communication link.
15

5. Method of controlling communication links of a communication system according to one of the claims 1 to 4, characterized in that the communication devices communicating via the at least one second communication
20   link in regular time intervals perform checks of the state of the communication channels and resume use of released communication channels until the original state of the at least one second communication link is restored.

25   6. Method of controlling communication links of a communication system according to one of the claims 1 to 5, characterized in that a request for the first communication link (100; 303; 402) is sent from a communication device to the control means (1), which in
30   response thereto performs a detection of the at least one second communication link, release of the at least one communication channel, and establishing the first communication link.

35   7. Method of controlling communication links of a communication system according to one of the claims 1 to

6, characterized in that a service record is checked and it is determined whether the at least one second communication link is available for releasing at least one of its communication channels.

5

8. Method of controlling communication links of a communication system according to one of the claims 1 to 7, characterized in that releasing a communication channel of the at least one second communication link includes:

10

sending a disconnect command (200) from control means (1) to the corresponding communication devices;

receiving a release message (201) from the
15   communication devices; and

sending a release complete message (202) from the control means to the corresponding communication devices.

20

9. Method of controlling communication links of a communication system according to one of the claims 1 to 8, characterized in that the communication devices of the second communication link are data processing units
25   conducting a multi-link PPP session via two ISDN-B-channels of an ISDN system (Integrated Digital Services Network).

10. Method of controlling communication links of a
30   communication system according to one of the claims 1 to 9, characterized in that the communication devices requesting the first communication link and the communication devices of the at least one second communication link include mobile communication units (12,
35   13, 14, 15) of a mobile communication network.

11. Communication system, comprising:

a plurality of communication devices (2 - 6, 8 - 15);

5   a plurality of communication links for communications between the plurality of communication devices, each communication link occupying at least one communication channel;

10   control means (1) including:

first detection means (501) for receiving a request for a first communication link and for receiving a termination message in case a communication link is
15   terminated;

second detection means (502) for determining at least one second communication link occupying at least two communication channels, in case a free communication
20   channel is not available;

switching means (7; 501, 503) for controlling the release of at least one communication channel of the at least one second communication link, and
25   establishing the first communication link via the released communication channel.

12. Communication system according to claim 11, characterized by means for reestablishing the at least one
30   second communication link to its original state, if communication channels becomes available.

13. Communication system according to claims 11 or 12,
characterized by poll means (504) connected to at least
one of the communication devices of the at least one
second communication link, for polling the state of
5   communication channels in time intervals for detecting an
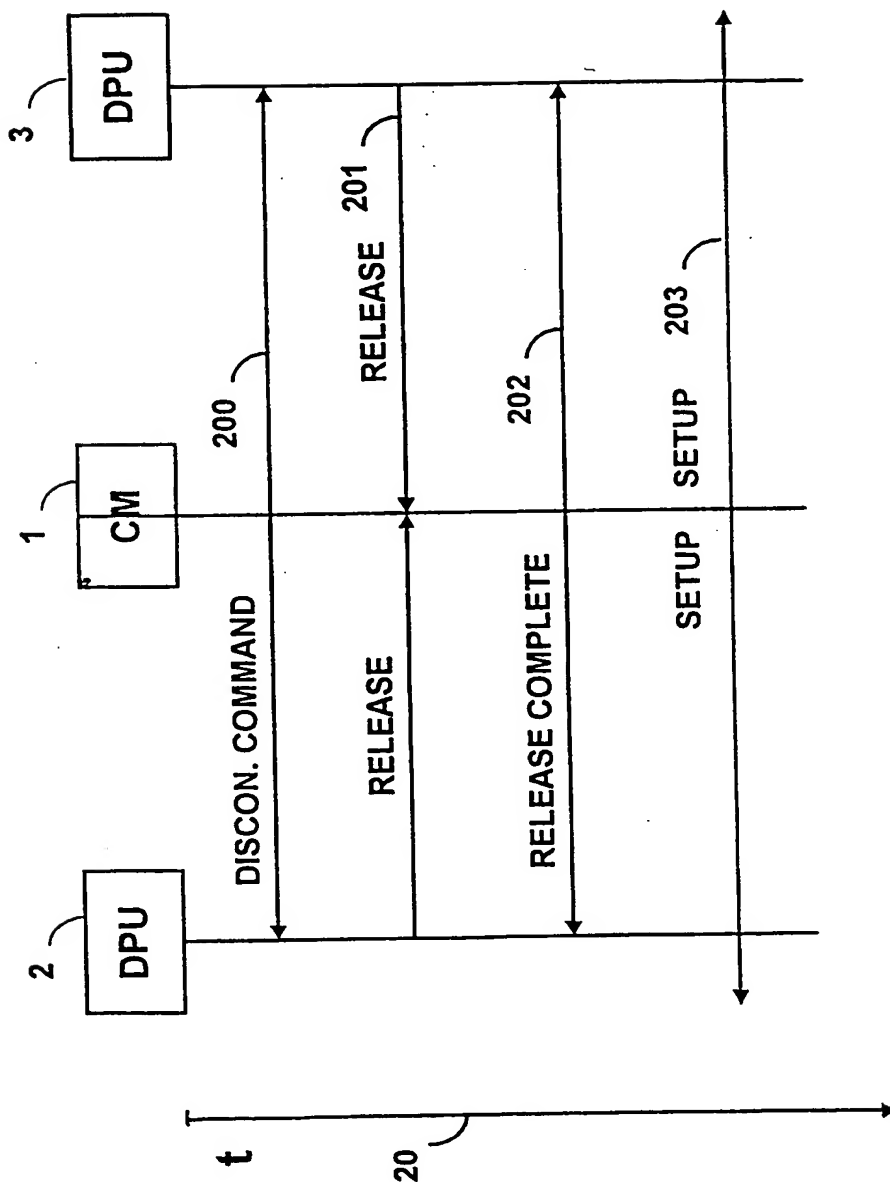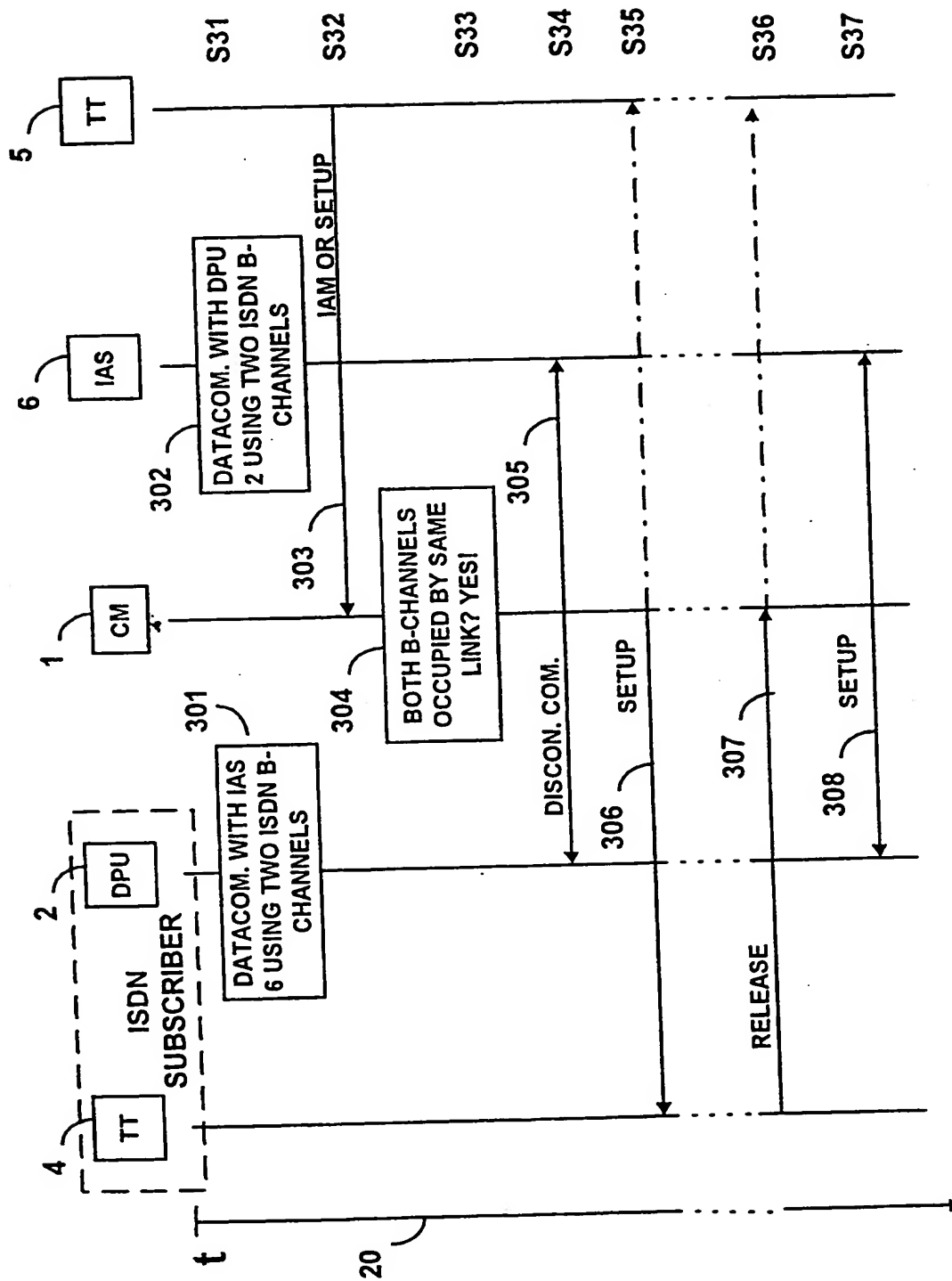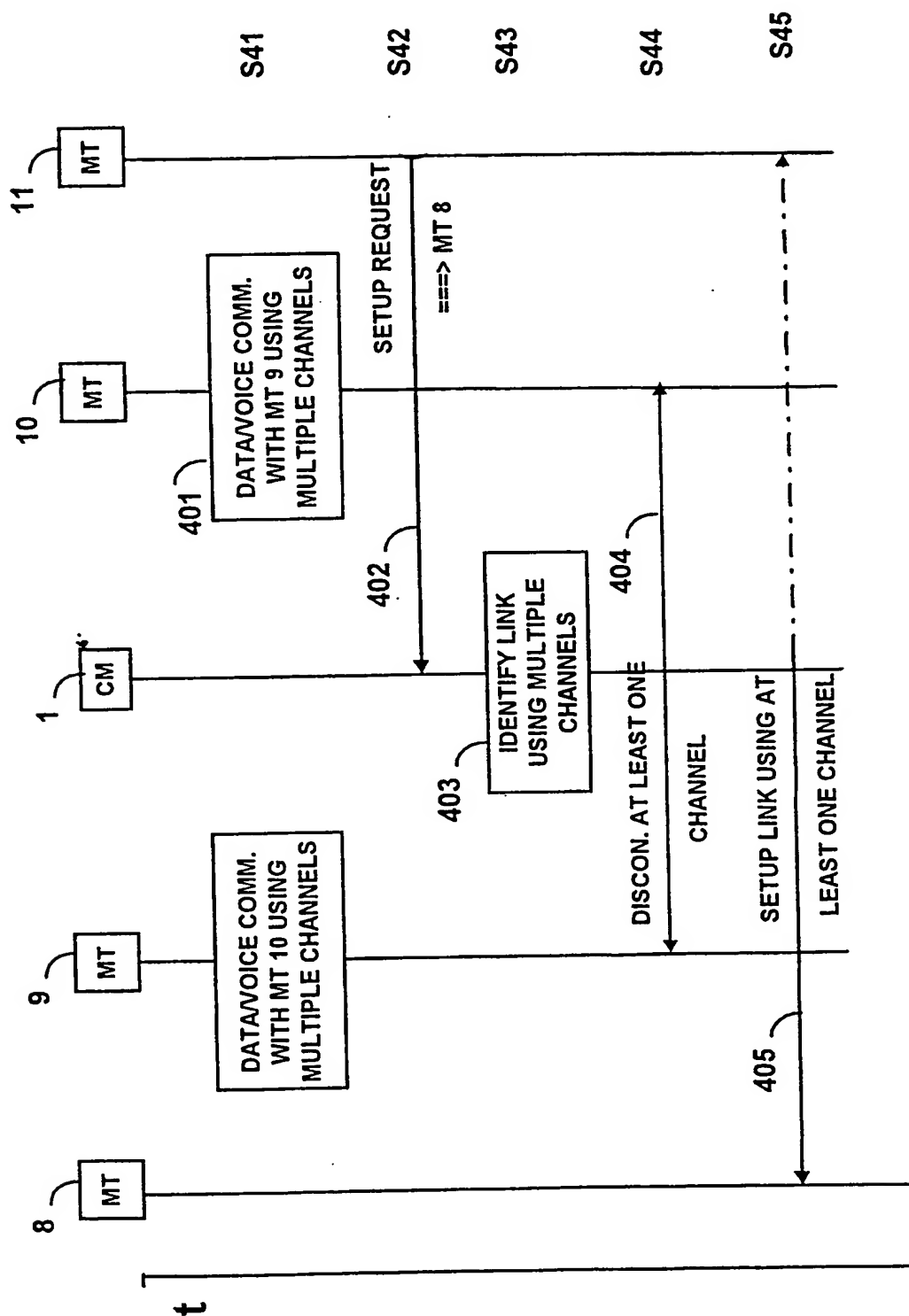available communication channel.
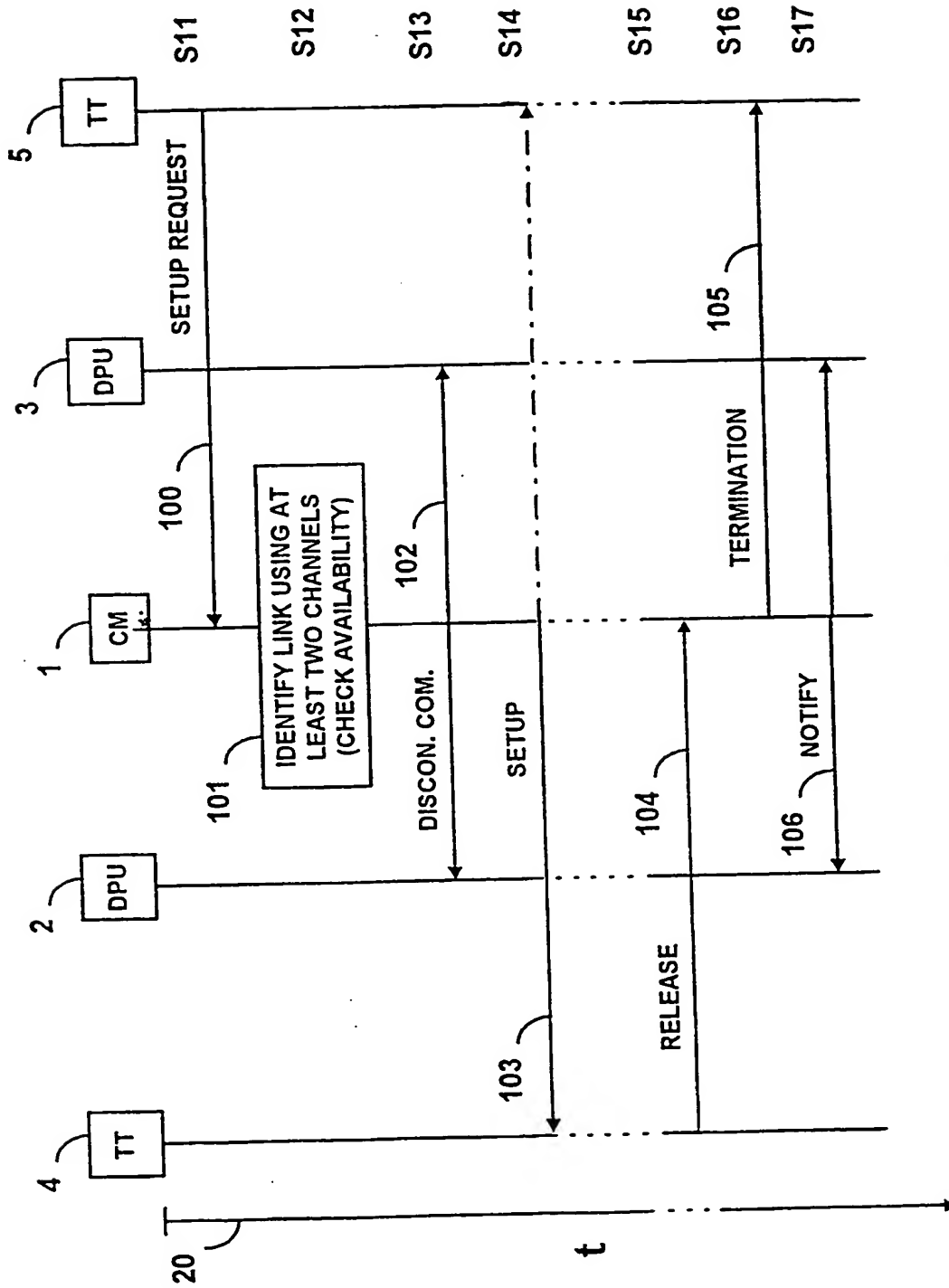
Fig. 1

Fig. 2

Fig. 3

Fig. 4
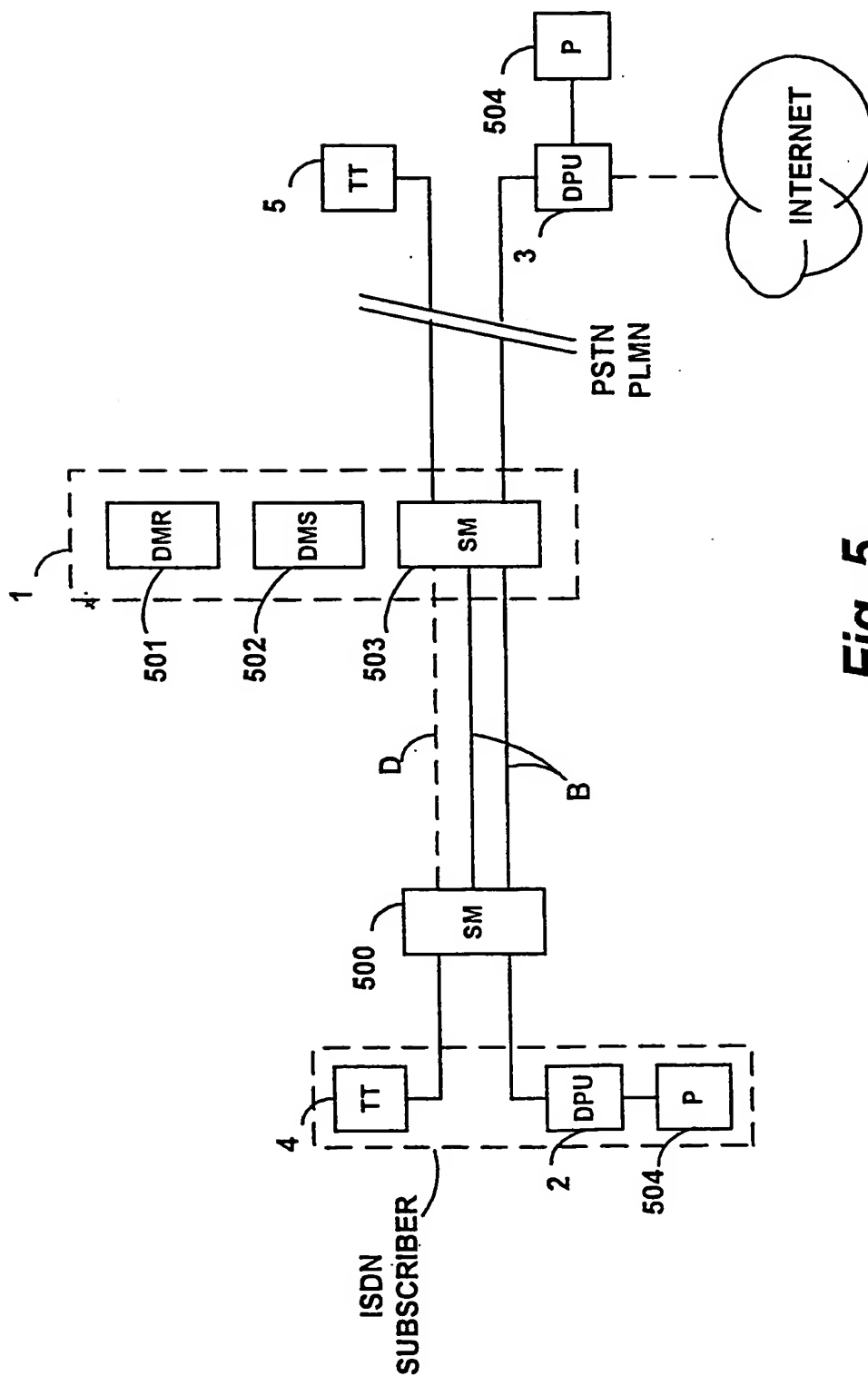
Fig. 5
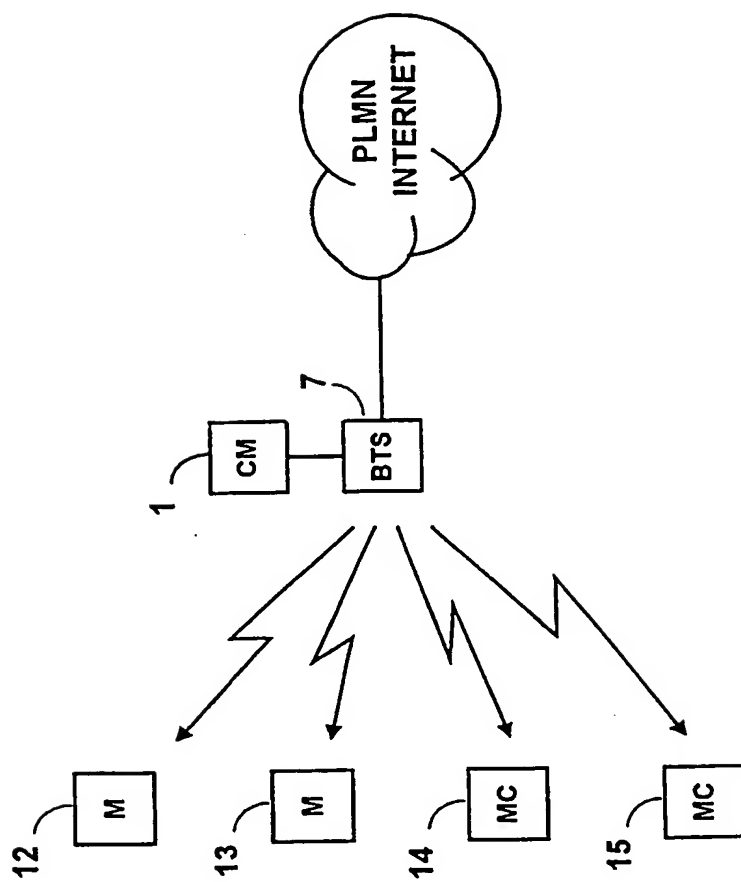
Fig. 6

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H04Q11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 317 415 A (KINAMI H ET AL) 31 May 1994 (1994-05-31) abstract column 2, line 3-20 column 2, line 62 - column 3, line 9 column 8, line 54-58 claims 1-4; figures 1,6,8	1,3,4,6, 8,11
A		2,9,12

X	WO 93 23809 A (CONNECTIVE STRATEGIES, INC) 25 November 1993 (1993-11-25) page 3, line 21 - page 4, line 9 page 44, line 14 - page 47, line 26 claims 45-50; figures 16A-17B	1,3,4,6, 11
A		2,9,12
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X	Further documents are listed in the continuation of box C.		X	Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 August 1999	16/08/1999

| Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Gijsels, W

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page 1 of 2

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	HANRATTY J M ET AL: "AN EVALUATION OF ISDN VIA ACTS IN SUPPORT OF ARMY WIDE AREA INFORMATION SERVICES" MILCOM '93, vol. 3, no. CONF. 12, 11 - 14 October 1993, pages 988-992, XP000410900 BEDFORD page 991, right-hand column, line 28-44	1,11
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E	FR 2 773 431 A (TELECOMMUNICATIONS SA) 9 July 1999 (1999-07-09) abstract page 2, line 21-30 claims 1-4; figure 1 -----	1,4,6,11
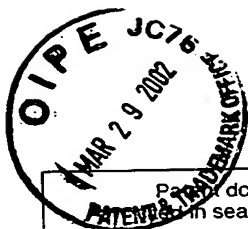
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